## CLAIMS

1. A method of fabricating a metamaterial comprising:

providing a sample of elongate engineered microstructured material comprising one or more elongate voids running substantially the length of the sample, the sample configured to transmit electromagnetic radiation;

providing a high pressure fluid comprising at least one semiconductor carried in at least one carrier fluid;

passing the high pressure fluid through the one or more voids; and

causing the semiconductor to deposit onto one or more surfaces of the one or more voids to form the metamaterial.

2. A method according to claim 1, in which the carrier fluid is in its supercritical phase.

3. A method according to claim 1, in which the high pressure fluid has a pressure of 1 MPa or above, or of 2.5 MPa or above, or of 5 MPa or above, or of 10 MPa or above, or of 25 MPa or above, or of 50 MPa or above, or of 100 MPa or above, or of 500 MPa or above, or of 1000 MPa or above, or of 2000 MPa or above.

4. A method according to any one of claims 1 to 3, in which the one or more voids have a length and a width such that the ratio of the length to the width is in the range 100:1 to 1000:1, or 100:1 to 10000:1, or 100:1 to 100000:1, or 100:1 to $10^6$:1, or 100:1 to $10^7$:1, or 100:1 to $10^8$:1, or 100:1 to $10^9$:1, or 100:1 to $10^{10}$:1, or 100:1 to $10^{11}$:1, or 100:1 to $10^{12}$:1, or 1000:1 to 10000:1, or 1000:1 to 100000:1, or 1000:1 to $10^6$:1, or 1000:1 to $10^7$:1, or 1000:1 to $10^8$:1, or 1000:1 to $10^9$:1, or 1000:1 to $10^{10}$:1, or 1000:1 to $10^{11}$:1, or 1000:1 to $10^{12}$:1 or 10000:1 to 100000:1, or 10000:1 to $10^6$:1, or 10000:1 to $10^7$:1, or 10000:1 to $10^8$:1, or 10000:1 to $10^9$:1, or 10000:1 to $10^{10}$:1, or

10000:1 to $10^{11}$:1, or 10000:1 to $10^{12}$:1, or 100000:1 to $10^{6}$:1, or 100000:1 to $10^{7}$:1, or 100000:1 to $10^{8}$:1, or 100000:1 to $10^{9}$:1, or 100000:1 to $10^{10}$:1, or 100000:1 to $10^{11}$:1, or 100000:1 to $10^{12}$:1

5. A method according to any preceding claim, in which the one or more voids have a width in the range 1 nm to 100nm.

6. A method according to any one of claims 1 to 5, in which the sample of microstructured material comprises a holey optical fibre.

7. A method according to any one of claims 1 to 5, in which the sample of microstructured material is planar.

8. A method according to any one of claims 1 to 7, in which the one or more voids have a smallest dimension between 1 nm and 1 μm.

9. A method according to claim 8, in which the engineered microstructured material, the at least one semiconductor and dimensions of the one or more voids are selected to give a metamaterial that is a mesomaterial.

10. A method according to any one of claims 1 to 7, in which the one or more voids have a smallest dimension between 1 μm and 1 mm.

11. A method according to any preceding claim, in which the sample of microstructured material is fabricated from one or more of: glass materials, plastics materials, ceramic materials, semiconductor materials and metallic materials.

12. A method according to any one of claims 1 to 11, in which the semiconductor is deposited to form one or more nanoparticles.

13. A method according to any one of claims 1 to 11, in which the semiconductor is deposited to form an annular layer.

14. A method according to claim 13, further comprising controlling the amount of semiconductor that is deposited to form an annular layer of a selected thickness.

15. A method according to claim 13 or claim 14, in which the annular layer comprises a thin film.

16. A method according to claim 15, in which the thickness of the annular layer is selected to reduce the width of the one or more voids to a selected size.

17. A method according to any preceding claim, and further comprising providing a further high pressure fluid comprising a further semiconductor and passing the further high pressure fluid through the one or more voids to cause the further semiconductor to deposit on the semiconductor previously deposited.

18. A method according to claim 15, and further comprising providing a further high pressure fluid comprising a further semiconductor and passing the further high pressure fluid through the one or more voids to cause the further semiconductor to deposit on the semiconductor previously deposited, in which the selected size of the one or more voids is such as to cause quantum confinement in the deposited further semiconductor.

19. A method according to any one of claims 1 to 13, in which the semiconductor is deposited on a surface of the one or more voids until the one or more voids is substantially filled with the semiconductor.

20. A method according to any one of claims 1 to 13, in which the semiconductor is deposited to create one or more quantum structures.

21. A method according to any one of claims 1 to 20, in which causing the semiconductor to deposit comprises heating the high pressure fluid as it passes through the one or more voids to cause the semiconductor to separate from the carrier fluid and deposit.

22. A method according to claim 21, comprising heating the high pressure fluid by heating selected portions of the sample for selected durations to control an amount of semiconductor that becomes deposited.

23. A method according to claim 21 or claim 22, in which heating the high pressure fluid comprises applying a temperature gradient along all or part of the sample.

24. A method according to claim 23, in which the temperature gradient is dynamically varying.

25. A method according to claim 23, in which the temperature gradient is static.

26. A method according to any one of claims 21 to 24, in which heating the high pressure fluid comprises heating a portion of the sample to create a heated zone, and

moving the heated zone along the sample to deposit the semiconductor sequentially along all or part of the sample.

27. A method according to claim 26, and further comprising implanting a plug of alloy-forming material in the one or more voids before passing the high pressure fluid through the one or more voids, passing the high pressure fluid through the one or more voids and allowing an alloy to form from the semiconductor and the alloy-forming material in the heated zone, the alloy depositing the semiconductor in response to the heat.

28. A method according to any one of claim 1 to 27, in which causing the semiconductor to deposit comprises altering the pressure of the high pressure fluid as it passes through the one or more voids to cause the semiconductor to separate from the carrier fluid and deposit.

29. A method according to any one of claims 1 to 27, in which causing the semiconductor to deposit comprises applying a pressure gradient along all or part of the sample as the high pressure fluid is passed through the one or more voids.

30. A method according to any one of claims 1 to 29, in which causing the semiconductor to deposit comprises applying a gradient in concentration of the semiconductor in the high pressure fluid along all or part of the sample as the high pressure fluid is passed through the one or more voids.

31. A method according to any one of claim 1 to 30, in which causing the semiconductor to deposit comprises providing a carrier fluid that can diffuse through the engineered microstructured material, and allowing the carrier fluid to diffuse

through walls of the one or more voids to leave the semiconductor within the one or more voids.

32. A method according to claim 31, in which the carrier fluid can further diffuse through the deposited semiconductor.

33. A method according to any one of claims 1 to 32, in which the semiconductor has a precursor form in the high pressure fluid, and causing the semiconductor to deposit comprises decomposing the precursor into the semiconductor and a by-product that can diffuse through the engineered microstructured material and allowing the by-product to diffuse through walls of the one or more voids.

34. A method according to claim 33, in which the precursor is a hydride of the semiconductor and the by-product is hydrogen.

35. A method according to any one of claims 1 to 34, in which causing the semiconductor to deposit comprises providing a semiconductor that will grow from a seed, and incorporating a seed into the one or more voids so that the semiconductor will grow within the one or more voids as the high pressure fluid passes through the one or more voids.

36. A method according to any preceding claim, in which causing the semiconductor to deposit comprises applying one or more deposition-causing conditions to the sample that vary along a gradient over all or part of the sample.

37. A method according to any one of claims 1 to 36, in which the carrier fluid is argon.

38. A method according to any one of claims 1 to 36, in which the carrier fluid is helium.

39. A method according to any one of claims 1 to 36, in which the carrier fluid is hydrogen.

40. A metamaterial comprising a sample of elongate engineered microstructured material having one or more elongate voids running substantially the length of the sample and semiconductor deposited on one or more surfaces of the one or more elongate voids.

41. A metamaterial according to claim 40, in which the semiconductor defines one or more quantum structures.

42. A metamaterial according to claim 40, in which the semiconductor is deposited as one or more annular layers.

43. A metamaterial according to claim 40 or claim 42, in which the semiconductor substantially fills one or more of the one or more elongate voids.